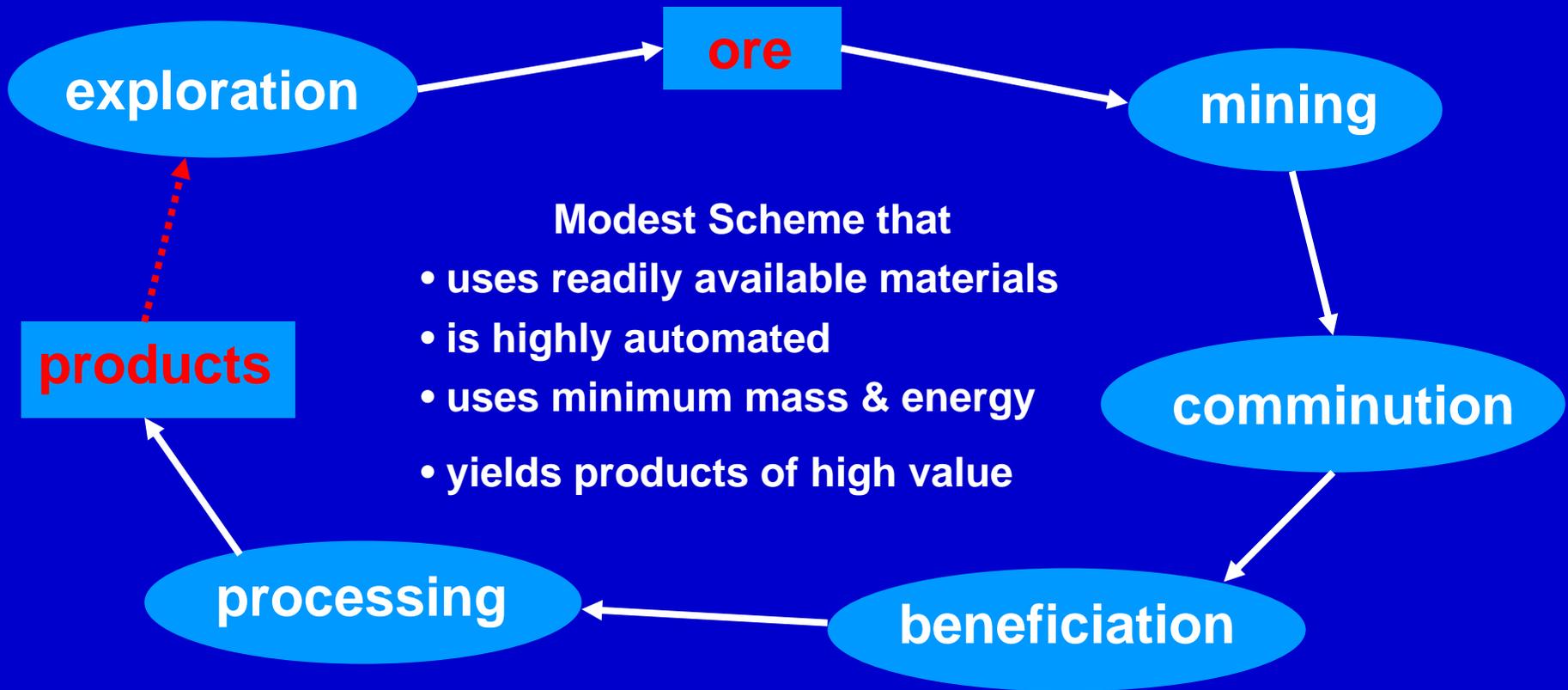


While accurate petrology is essential, a simulant must also faithfully respond to processing. The consequence of failure would be devastating.



Oxygen Production & Lunar Regolith Simulant: Pyrometallurgical Processing

Reaction Schemes

Hydrogen Reduction

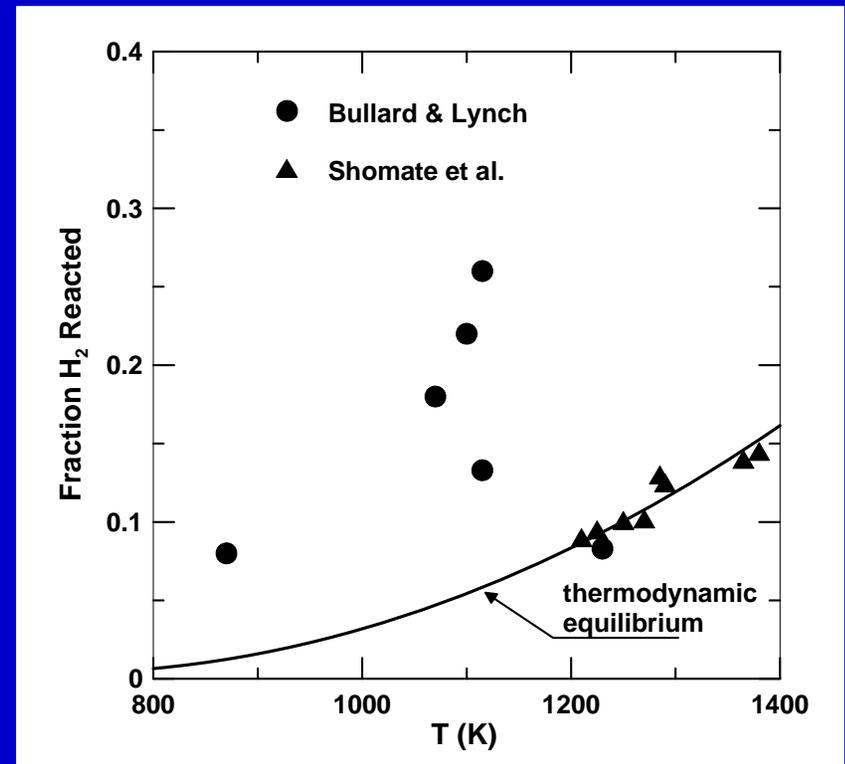
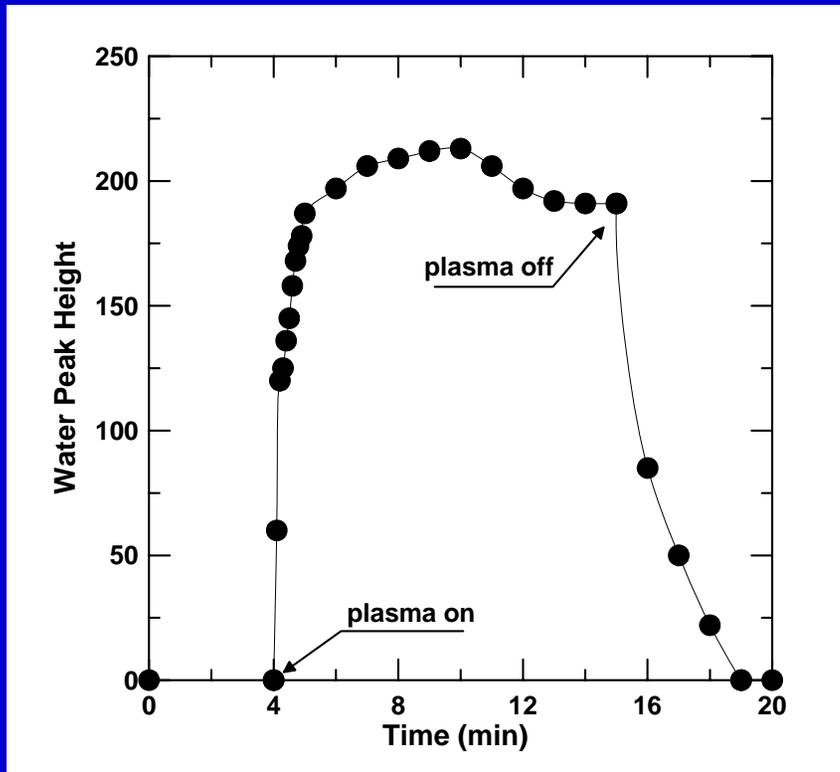


Carbothermic Reduction

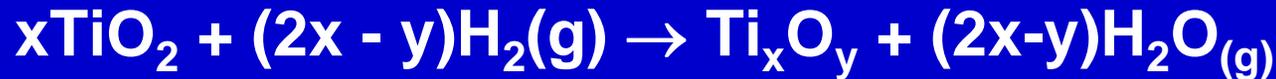


with production of O_2 through electrolysis of $\text{H}_2\text{O}(\text{l})$ or $\text{CO}_2(\text{g})$. Thus Mare soils with a high ilmenite content are prime candidates for simulation.

Impact of Hydrogen Plasma

$$\text{FeTiO}_3 + 2\text{H}(\text{g}) \rightarrow \text{Fe} + \text{H}_2\text{O}(\text{g}) + \text{TiO}_2$$


Reduction of TiO₂



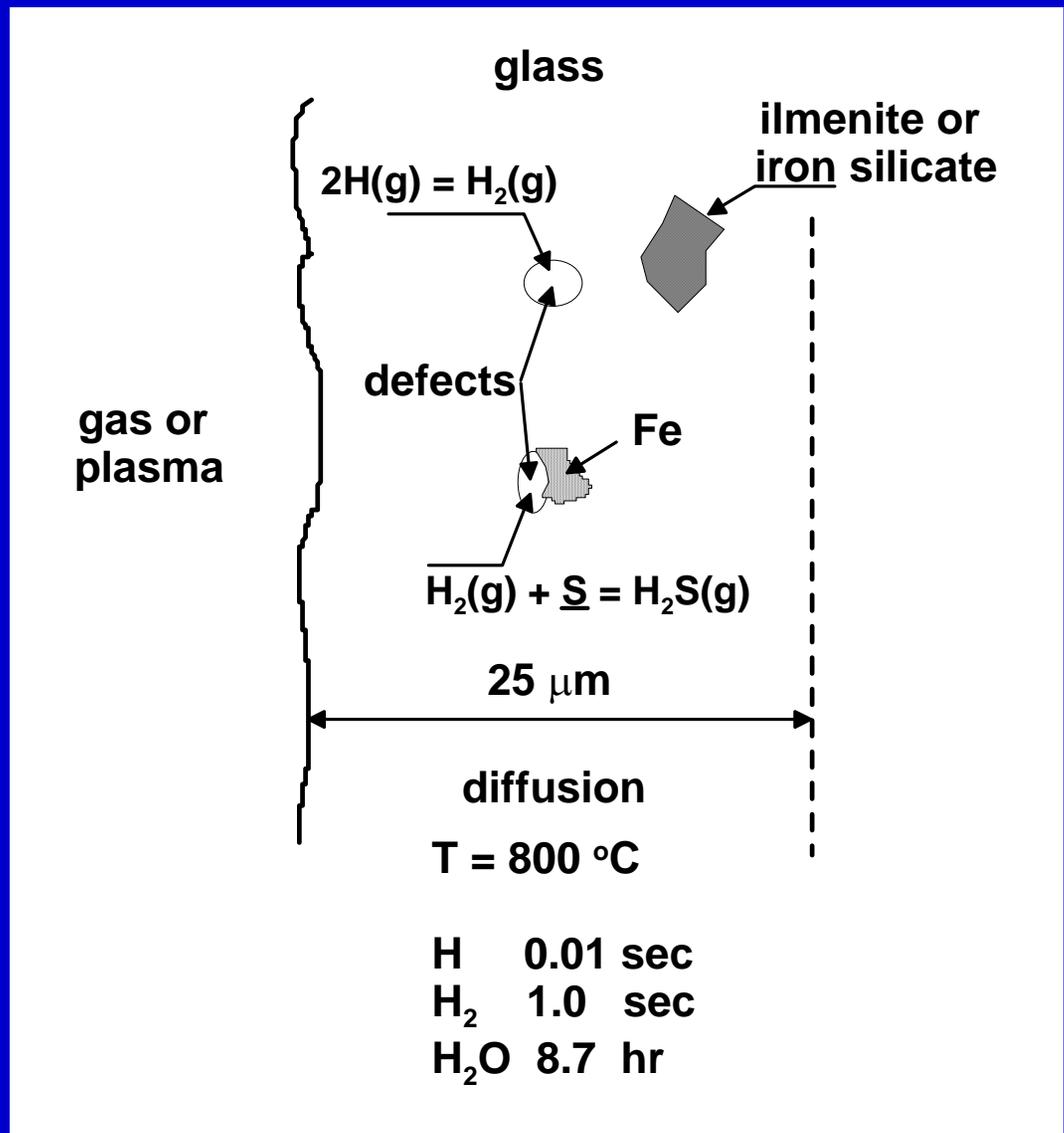
Ti _x O _y :	Ti ₅₀ O ₉₉ (1.98)	Ti ₅ O ₉ (1.80)
	Ti ₁₆ O ₃₁ (1.94)	Ti ₄ O ₇ (1.75)
	Ti ₉ O ₁₇ (1.89)	Ti ₃ O ₅ (1.67)
	Ti ₈ O ₁₅ (1.88)	Ti ₂ O ₃ (1.50)
	Ti ₆ O ₁₁ (1.83)	TiO (1.00)

Reduction of TiO₂

Investigation	T (K)	P _{Total}	% H ₂	O/Ti molar ratio in product
Zhao & Shadmann	1100	0.93 atm	3.4	2
	1160			1.98
	1223			1.96
	1290			1.94
Zhao & Shadmann	1223	0.93 atm	6.4	1.94
Zhao & Shadmann	1023	0.93 atm	14.7	1.90
	1223			1.83
	1290			1.83
Allen et al.	1323	1 atm	100	1.83
	1373			1.75
Bullard & Lynch	1020 –	6 – 18 Torr	100	1.50
	1205			
	1255	26 Torr	100	1.0 ???
	1260			

Impact of hydrogen & defects on reaction rates

$$X = (D \cdot t)^{1/2}$$



Oxygen Production & Lunar Regolith Simulant: Processing (Reduction)

Ore Properties

- feed composition
- particle size & size of ilmenite grains in particles
- availability of ilmenite for reaction
- specific heat of feed
- surface area
- porosity
- particle strength - before and after processing

Desired Attributes for Processing

- high reactivity for desired products
- minimize volatile trace elements (S ??)
- maximize production per volume of ore processed
- controlled particle size (fluidization & time of reaction)
- bed stability